

CLAIMS

What is claimed is:

1. A fusion implant for insertion between opposing bony structures in load bearing arrangement, the implant comprising:

a body having first and second pieces of bone assembled together to form a construct having exterior surfaces; and

at least one pin projecting into the first and second body pieces to hold them together, the pin having a first end and a second end, a portion of the pin tapering between the first and second ends.
2. The implant of claim 1 wherein the at least one pin is chamfered at least one of its first and second ends.
3. The implant of claim 1 wherein the pin extends from a first exterior surface partway toward a second exterior surface such that the pin is exposed at the first surface and stops short of the second surface.
4. The implant of claim 1 wherein the tapered portion of the pin tapers away from a first exterior surface toward a second exterior surface such that the pin has a larger portion that is near the first exterior surface and a smaller portion that is near the second exterior surface.
5. The implant of claim 4 further comprising a second pin with a second tapered portion, the second tapered portion tapering away from the second exterior surface toward the first exterior surface such that the second pin has a larger portion that is near the second exterior surface and a smaller portion that is near the first exterior surface.
6. The implant of claim 5 wherein each pin further has a longitudinal axis and a diameter associated with its larger end, the axes of the pins crossing one another within the

body at a distance between the axes that is less than one-half the sum of the diameters of the larger ends of the pins such that one pin passes through the envelope of the other.

7. The implant of claim 1 wherein the pin extends through the body from one exterior surface to another.
8. The implant of claim 1 wherein the pin is embedded within the body, such that it is surrounded on all sides by the body.
9. The implant of claim 1 wherein the body further comprises a third piece of bone positioned between the first and second pieces, the first and second pieces comprising bone having a first load bearing capacity and the third piece comprising bone having a second load bearing capacity, the pin extending into each of the pieces to hold the construct together.
10. The implant of claim 1 wherein the body further comprises a third piece of bone sandwiched between the first and second pieces, the first and second pieces comprising relatively dense bone and the third piece comprising relatively porous bone, the pin extending into each of the pieces to hold the construct together.
11. The implant of claim 10 wherein the first and second pieces comprise cortical bone and the third piece comprises cancellous bone.
12. The implant of claim 11 wherein the pin comprises cortical bone.
13. The implant of claim 10 wherein the exterior surfaces include opposing sides for contacting the adjacent bony structures, the first, second, and third pieces being aligned side by side such that each piece spans the adjacent bony structures, the body further including an opening through the third piece communicating with the adjacent bony structures.
14. The implant of claim 10 wherein the exterior surfaces include opposing sides for contacting the adjacent bony structures, the body further comprising a fourth piece of bone

- comprising relatively porous bone, the four pieces of bone being aligned side by side such that each piece spans the adjacent bony structures, the third and fourth pieces being spaced apart to form an opening through the body communicating with the adjacent bony structures.
15. The implant of claim 1 further comprising an opening through the body communicating with the adjacent bony structures.
16. The implant of claim 15 further comprising a bone growth promoting substance in the opening.
17. The implant of claim 16 wherein the bone growth promoting substance comprises at least one substance selected from the group consisting of bone paste, cancellous bone, bone chips, bone morphogenic protein, LIM mineralization protein, platelet derived growth factors, bone marrow aspirate, stem cells, and biologic growth factors.
18. The implant of claim 1 wherein the pin comprises at least one material selected from the group consisting of bone, metal, ceramic, carbon, bioglass, and polymers.
19. The implant of claim 1 further comprising a second pin.
20. The implant of claim 1 wherein the pin angles through the construct obliquely such that it is neither parallel nor perpendicular to any of the exterior surfaces.
21. The implant of claim 1 further comprising a fixation device attached to the adjacent bony structures to limit the relative motion between them.
22. The implant of claim 21 wherein the fixation device substantially prevents all relative motion between the adjacent bony structures.
23. The implant of claim 21 wherein the fixation device allows a predetermined amount of relative motion between the adjacent bony structures during the fusion process.

24. The implant of claim 21 wherein the fixation device is selected from the group consisting of plates, internal rod systems, external rod systems, cable systems, cerclage systems, screws, and combinations thereof.
25. A fusion implant for insertion between opposing bony structures in load bearing arrangement, the implant comprising:
- a body having first and second pieces of bone assembled together to form a construct;
 - and
 - at least one pin projecting into the first and second body pieces to hold them together, the pin having a first dimension adjacent an end and a second dimension spaced from the end into the body.
26. The implant of claim 25 wherein the first dimension is greater than the second dimension.
27. The implant of claim 25 further comprising a fixation device attached to the adjacent bony structures to limit the relative motion between them.
28. A fusion implant for insertion between opposing bony structures in load bearing arrangement, the implant comprising:
- a body having first and second pieces of bone assembled together to form a construct having exterior surfaces; and
 - a pin projecting into the first and second body pieces to hold them together, the pin angling through the construct obliquely such that it is neither parallel nor perpendicular to any of the exterior surfaces.
29. The implant of claim 28 further comprising a fixation device attached to the adjacent bony structures to limit the relative motion between them.

30. A fusion implant for insertion between opposing bony structures in load bearing arrangement, the implant comprising:
- a body having first and second pieces of bone assembled together; and
 - a pin projecting into the first and second body pieces to hold them together, the pin being embedded within the body, such that it is surrounded on all sides by the body.
31. A fusion implant for insertion between opposing bony structures in load bearing arrangement, the implant comprising:
- a body having first, second, and third pieces of bone assembled together, the pieces being aligned side-by-side with the second piece of bone positioned between the first and third pieces of bone such that each piece spans the adjacent bone structures, the body including an opening through the third piece communicating with the adjacent bony structures.
32. The implant of claim 31 further comprising a fusion promoting substance.
33. The implant of claim 31 further comprising a fixation device attached to the adjacent bony structures to limit the relative motion between them.
34. A fusion implant for insertion between opposing bony structures in load bearing arrangement, the implant comprising:
- a body having first, second, third and fourth pieces of bone assembled together, the pieces being aligned side-by-side with the second and third pieces of bone positioned between the first and fourth pieces of bone such that each piece spans the adjacent bony structures, the second and third pieces being spaced

apart to form an opening through the body communicating with the adjacent bony structures.

35. A system for use in fusing adjacent bony structures, comprising:
a body having first and second pieces of bone assembled together to form a construct having exterior surfaces;
a pin projecting into the first and second body pieces to hold them together, the pin having a first end and a second end, the portion of the pin tapering between the first and second ends; and
a fixation device attachable to the adjacent bony structures and having a structure to limit relative motion between the adjacent bony structures.
36. A system for use in fusing adjacent bony structures, comprising:
a body having first and second pieces of bone assembled together to form a construct having exterior surfaces;
a pin projecting into the first and second body pieces to hold them together, the pin angling through the construct obliquely such that it is neither parallel nor perpendicular to any of the exterior surfaces; and
a fixation device attachable to the adjacent bony structures and having a structure to limit relative motion between the adjacent bony structures.
37. A system for use in fusing adjacent bony structures, comprising:
a body having first, second, and third pieces of bone assembled together, the pieces being aligned side-by-side with the second piece of bone positioned between the first and third pieces of bone such that each piece spans the adjacent bone

structures, the body including an opening through the third piece communicating with the adjacent bony structures; and
a fixation device attachable to the adjacent bony structures and having a structure to limit relative motion between the adjacent bony structures.

38. A method of treating adjacent bony structures comprising:
providing a body having first and second pieces of bone assembled together to form a construct having exterior surfaces, and a pin projecting into the first and second body pieces to hold them together, the pin having a first end and a second end, a portion of the pin tapering between the first and second ends;
and
positioning the implant between the adjacent bony structures in load bearing arrangement.

39. A method of treating adjacent bony structures comprising:
providing a body having first and second pieces of bone assembled together to form a construct having exterior surfaces, and a pin projecting into the first and second body pieces to hold them together, the pin angling through the construct obliquely such that it is neither parallel nor perpendicular to any of the exterior surfaces; and
positioning the implant between the adjacent bony structures in load bearing arrangement.

40. A method of treating adjacent bony structures comprising:
providing a body having first, second, and third pieces of bone assembled together, the pieces being aligned side-by-side with the second piece of bone positioned

between the first and third pieces of bone such that each piece spans the adjacent bone structures, the body including an opening through the third piece communicating with the adjacent bony structures; and positioning the implant between the adjacent bony structures in load bearing arrangement.

41. A method of making a bone implant comprising:
forming first and second bone pieces;
assembling the first and second pieces to form a body; and
inserting a pin into the body to hold the assembly together, the pin having a first end and a second end, a portion of the pin tapering between the first and second ends.

42. A method of making a bone implant comprising:
forming first and second bone pieces;
assembling the first and second pieces to form a body having exterior surfaces; and
inserting a pin into the body to hold the assembly together, the pin angling through the construct obliquely such that it is neither parallel nor perpendicular to any of the exterior surfaces.